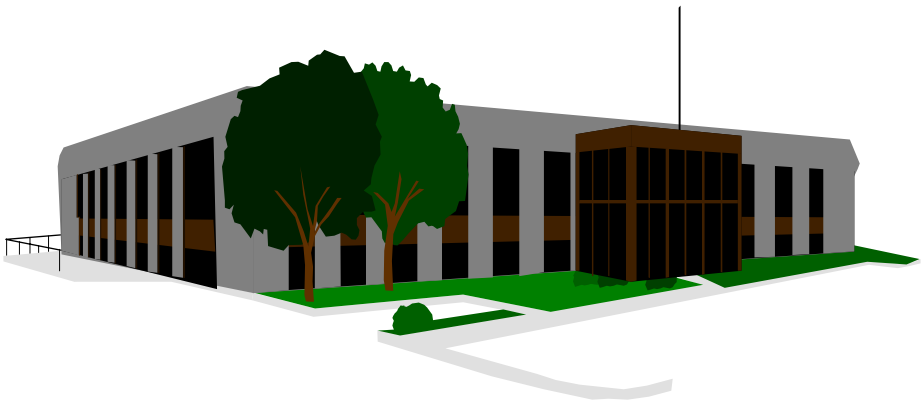
INDOOR AIR QUALITY ASSESSMENT

Hosmer Elementary School
1 Concord Road
Watertown, Massachusetts



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
January, 2002

Background/Introduction

At the request of a parent, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Hosmer Elementary School, One Concord Road, Watertown, MA. On September 14, 2001, Cory Holmes, Environmental Analyst for BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) program, conducted an assessment of this building. Mr. Holmes was accompanied by Frank Pannesi of the Watertown Health Department and for portions of the assessment Paul Anastasi, Director of Maintenance, Watertown Public Schools. Concerns about poor indoor air quality related to construction/renovations prompted the request. Findings and recommendations concerning renovations were previously outlined in a letter (MDPH, 2001).

The school was under renovation while occupied by students, teachers and school administration employees. Students and employees occupy the Hosmer Elementary School building and use portions of the former East Junior High School for lunch, gym and art. Occupants use a passageway constructed of plywood to travel between buildings. Planned renovations include an addition of the Hosmer Elementary School building as well as complete renovation of the second floor. This work is reportedly scheduled for the summer of 2002.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor Model 8551. Screening for total volatile

organic compounds (TVOCs) was conducted using a Thermo Environmental Inc., Photo Ionization Detector (PID). Air tests for ultrafine particulates to determine efficacy of renovation containment were taken with the TSI, P-Trak ™ Ultrafine Particle Counter Model 8525.

Results

The school houses kindergarten through sixth grades with a student population of approximately 500 and a staff of approximately 100. Tests were taken during normal operations at the school and results appear in Tables 1-4.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in four of twenty-seven areas surveyed, indicating adequate air exchange in most areas of the school. It should be noted that the assessment was conducted on a warm day and a number of areas had windows or exterior doors open during the assessment. Open windows can greatly reduce carbon dioxide levels. The general MDPH approach to resolving indoor air quality problems is primarily two-fold: 1) improving ventilation to dilute and remove environmental pollutants and 2) reduce or eliminate exposure to materials that may be adversely affecting indoor air quality.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (see Picture 1). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of

each unit (see Figure 1). Fresh air and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. Univents in classrooms 7, 9, 11 and 13 were not operating during the assessment, which can indicate a mechanical problem or deactivation. Obstructions to airflow were also seen in a number of classrooms (see Picture 2). These included books, papers and posters on top of univents, as well as bookcases, tables and desks in front of univent returns. To function as designed, univent fresh air diffusers and return vents must remain free of obstructions. It is important that univents be activated and allowed to operate during school hours.

The mechanical exhaust ventilation system in classrooms consists of grated, wall-mounted vents. Exhaust vents were not functioning in classrooms 9, 11 and 13 during the assessment, which can indicate either a mechanical problem or deactivation. The exhaust vent in classroom 207 was missing its grate. A number of exhaust vents were obstructed by tables, chairs, boxes and other items (see Picture 3). The location of exhaust vents can also limit exhaust efficiency when the classroom hallway door is open. When a classroom door is open, exhaust vents will tend to draw air from both the hallway and the classroom (see Picture 3). The open hallway door reduces the effectiveness of an operating exhaust vent to remove common environmental pollutants from classrooms. Without removal by the exhaust ventilation, normally occurring environmental pollutants can build up and lead to indoor air complaints.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical ventilation system, the systems must be balanced to

provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The last balancing of these systems reportedly took place within the last two to three years. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated

temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature measurements ranged from 68° F to 77° F, which were mostly within the BEHA comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ° F to 78 ° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 42 to 57 percent, which was within the BEHA recommended comfort range. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Spaces between the sink countertop and backsplash were noted in several classrooms (see Picture 4). Improper sink drainage or overflow could lead to water penetration of countertop wood, the cabinet interior and behind cabinets. Like other porous materials, if these materials become wet repeatedly they can provide a medium for mold growth, which is difficult to clean and can be irritating to sensitive individuals. These countertops are scheduled for replacement during subsequent renovations.

Along the perimeter of the building, shrubbery and other plants were noted in close proximity to univent fresh air intakes (see Pictures 5 & 6). Shrubbery and plants can be a source of mold and pollen and should be placed and/or maintained to ensure that fresh air intakes remain clear of obstructions to prevent the entrainment of particulates into the building. Care should also be taken to ensure that fresh air intakes remain clear of snowdrifts during winter months. In addition, the growth of roots against the exterior walls, as well as spaces between the tarmac and exterior walls of the building, can bring moisture in contact with wall brick and eventually lead to cracks and/or fissures in the foundation below ground level. Over time, this process can undermine the integrity of the building envelope and provide a means of water entry into the building through capillary action through foundation concrete and masonry (Lstiburek J., & Brennan, T., 2001).

In a number of classrooms caulking around the interior and exterior windowpanes was crumbling, missing or damaged (see Picture 7). Repairs of window leaks are necessary to prevent water penetration. Repeated water damage can result in mold colonization of window frames, curtains and items stored on or near windowsills.

Univent fresh air intakes for some ground floor classrooms are located within subterranean, cement-walled pits (see Picture 8). An accumulation of leaves and debris was noted in these pits (see Picture 9). Wet leaves and trash can provide a medium for mold growth & odors that can be entrained into the building by the air handling equipment.

Other Concerns

Several conditions that can potentially affect indoor air quality were also identified. Exposed fiberglass insulation was noted in the interior of the univent in classroom 108 (see Picture 10). The presence of exposed fiberglass insulation inside the univent air diffuser coupled with air movement provides the opportunity for particulates to become airborne. Also of note was the amount of materials stored in some areas. In many classrooms and common areas items were seen piled on windowsills, tabletops, counters, bookcases and desks (see Picture 11). The large amount of items stored provides a means for dusts, dirt and other potential respiratory irritants to accumulate. These stored items (e.g., papers, folders, boxes, etc.) also make it difficult for custodial staff to clean. Household dust and fiberglass insulation can become easily aerosolized and serve as a source of eye and respiratory irritation. In addition, fiberglass insulation material can also serve as a source of skin irritation to sensitive individuals.

Cleaning products, unlabelled spray bottles and flammable materials were found on countertops and underneath sinks in a number of classrooms. Many of the sinks had cabinet doors open or were missing doors entirely (see Picture 12), allowing easy student access. Cleaning products and flammables contain chemicals, which can be irritating to the eyes, nose and throat. These materials should be stored properly and kept out of reach of students. In addition, these materials should be clearly labeled or stored in their original containers.

The school's dumpster is located behind the building. Although no reports of trash odors were reported, the close proximity of the dumpster to the building may

provide for nuisance odors to enter classrooms through the univent fresh air intake (see Picture 13) or by open windows during the spring and summer months.

Conclusions/Recommendations

In view of the findings at the time of this assessment, the following recommendations are made:

1. Implement recommendations listed in previous BEHA correspondence (MDPH, 2001).
2. Restore univents and exhaust vents in classrooms 7, 9, 11 and 13 to working order.
3. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy.
4. Remove all blockages from univents and exhaust vents to ensure adequate airflow. Close classroom hallway doors to maximize exhaust ventilation.
5. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

6. Continue with plans to replace sink countertops during subsequent renovations. If not replaced, seal areas around sink to prevent water-damage to the interior of cabinets and adjacent wallboard. Inspect wallboard for water-damage and mold/mildew growth, repair/replace as necessary. Disinfect areas of microbial growth with an appropriate antimicrobial as needed.
7. Clean accumulated leaves and debris from fresh air intake pits.
8. Continue with plans to replace windows. If not replaced, repair missing or damaged window caulking building-wide to prevent water penetration and drafts through window frames.
9. Inspect univent fresh air intakes along outside perimeter of building periodically; clear away shrubbery, plant growth and snowdrifts (during winter) as needed.
10. Store chemicals and cleaning products properly and out of the reach of students. Ensure products are properly labeled in the event of an emergency for identification purposes.
11. Remove or encapsulate damaged/exposed fiberglass in classroom 108 univent.
12. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning of classrooms. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
13. Consider relocating the dumpster further away from the building. If not feasible, ensure access panels are closed to contain odors.

References

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

Lstiburek, J. & Brennan, T. 2001. Read This Before You Design, Build or Renovate. Building Science Corporation, Westford, MA. U.S. Department of Housing and Urban Development, Region I, Boston, MA.

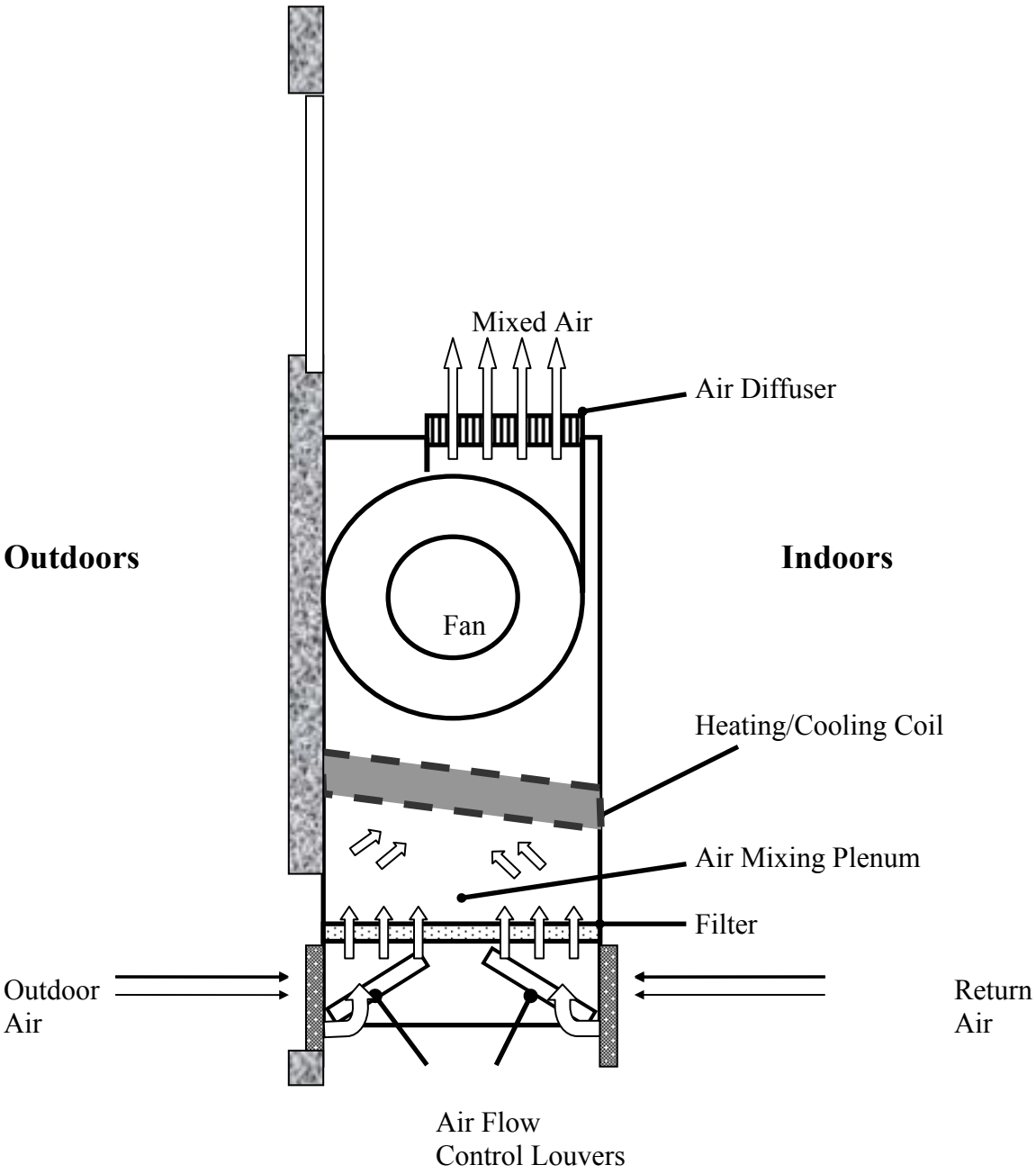
MDPH. 2001. Letter to Dr. Sally Dias, Superintendent, Watertown Public Schools from Suzanne Condon, Assistant Commissioner, BEHA Concerning Renovations/Construction at the Hosmer Elementary School, Weymouth, MA, Dated November 1, 2001. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

Figure 1 **Unit Ventilator (Univent)**



Picture 1

Classroom Unit Ventilator (Univent)

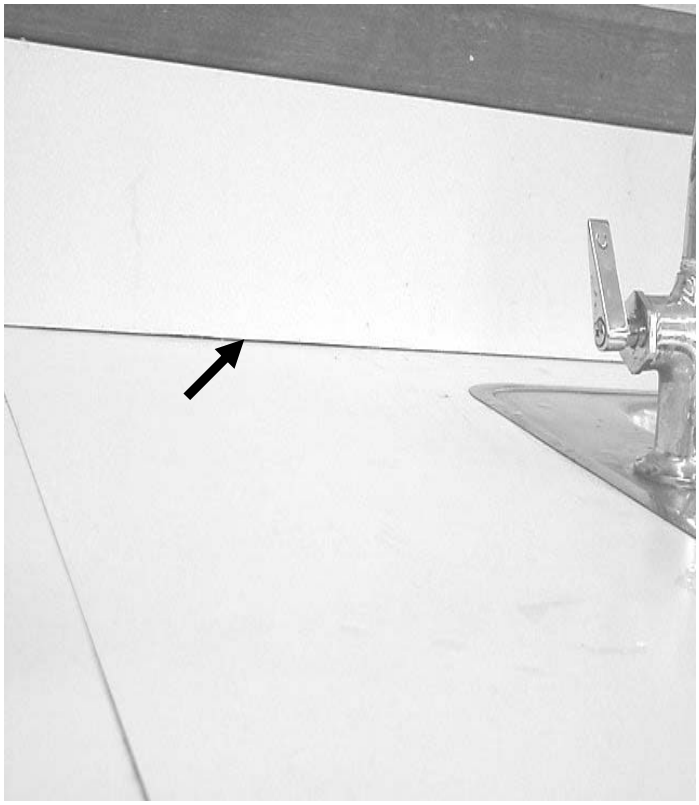
Picture 2

Classroom Univent Obstructed by Various Items

Picture 3

Obstructed Classroom Exhaust Vent, Also Note Open Door

Picture 4



Space between Sink Countertop and Backsplash

Picture 5

Plant growth along Exterior Wall/Tarmac In Front of Univent Air Intake

Picture 6

Shrubbery Obstructing Univent Fresh Air Intake

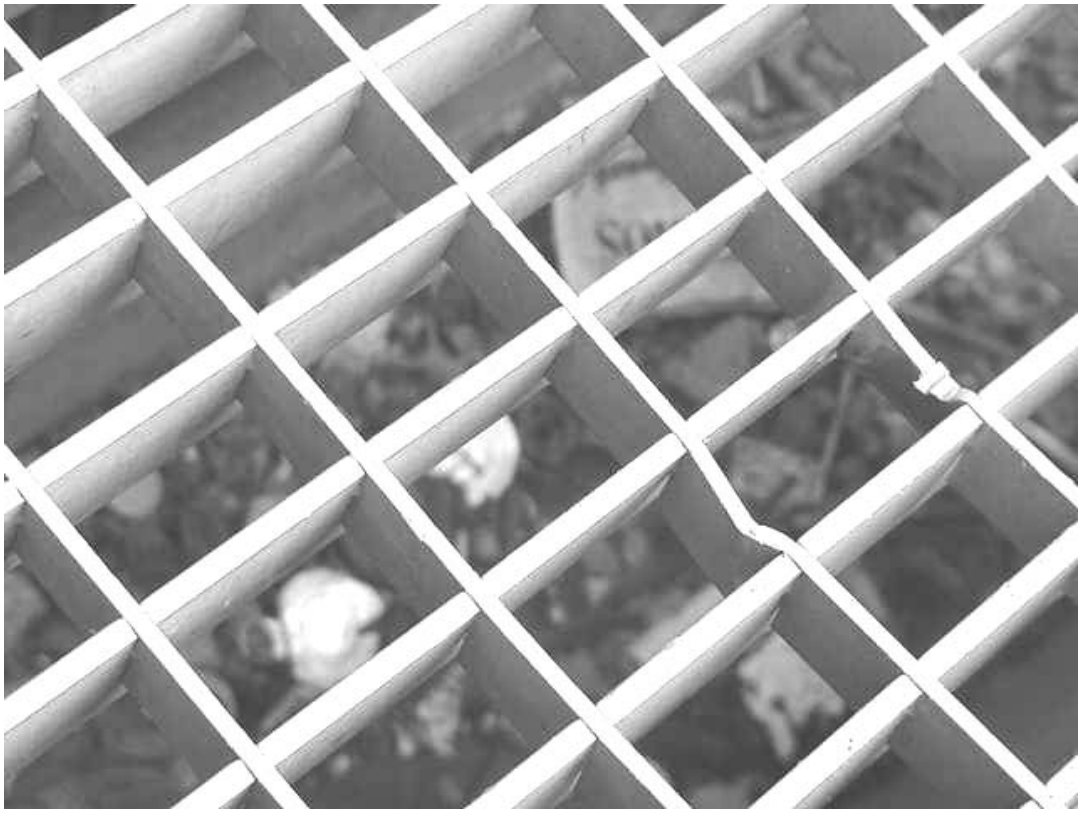
Picture 7

Missing/Damaged Window Caulking

Picture 8

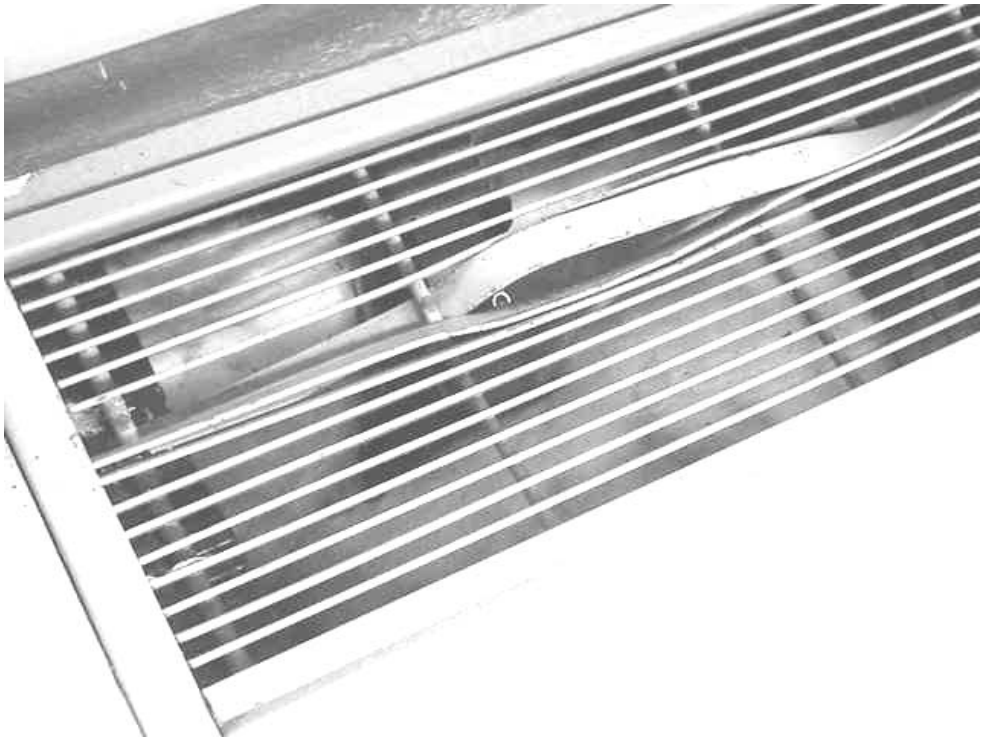
Subterranean Pit Containing Univent Fresh Air Intake

Picture 9



Accumulated Leaves and Debris in Subterranean Pit Depicted in Picture 8

Picture 10



Exposed Fiberglass Insulation in Univent Interior (Air Diffuser)

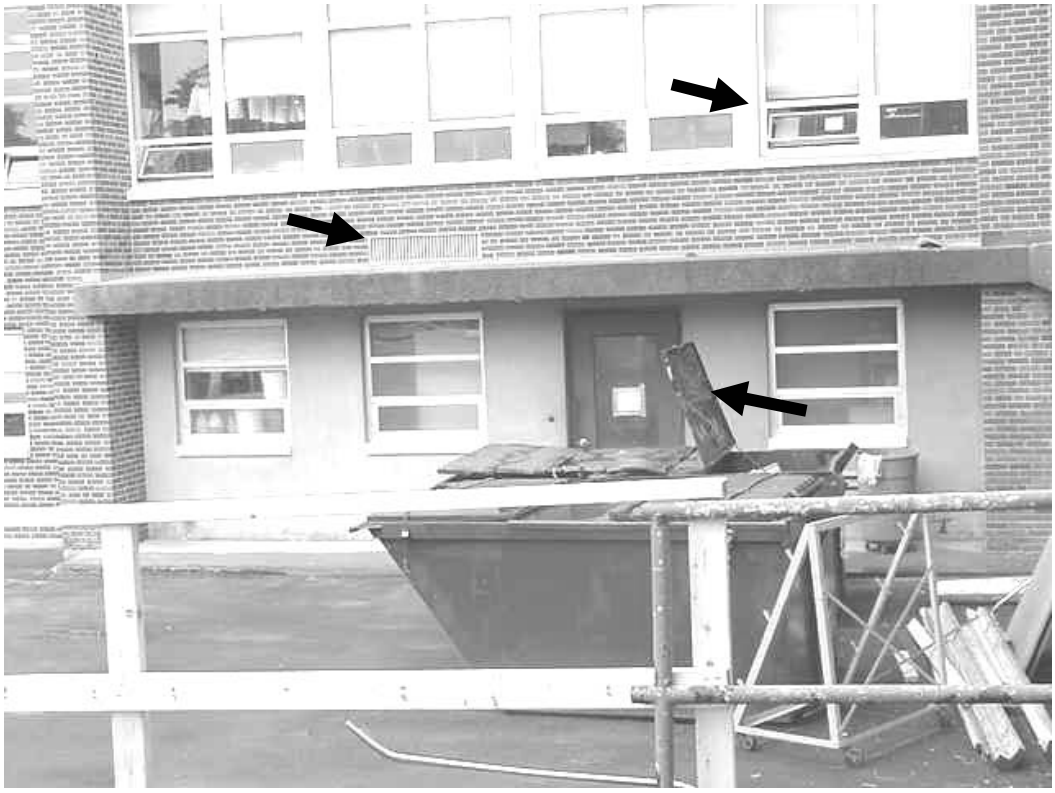
Picture 11

Items in Classroom Covering Flat Surfaces Making Dust Control Difficult

Picture 12

Cleaning Products Stored On/Beneath Classroom Sink

Picture 13



Proximity of Dumpster to Univent Fresh Air Intake and Open Window
Note Open Access Panel to Dumpster

TABLE 1

Indoor Air Test Results – Hosmer Elementary School, Watertown, MA – September 14, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	409	63	52					Weather conditions: wet, rainy
Room 104	660	71	57	17	Yes	Yes	Yes	Missing/damaged caulking around window, window open
Resources Room	475	74	49	4	Yes	Yes	Yes	Window not fully closed, construction vehicle outside
Teacher's Workroom	434	75	45	1	Yes	Yes	Yes	Lamination machine, 2 photocopiers, exhaust vent
Room 111	536	71	45	0	Yes	Yes	Yes	Window open, exhaust vent blocked, items on univent, accumulated items, cleaning materials under sink – "Goo Gone"/spray bottles/glass cleaner/degreaser
Room 207	718	76	44	17	Yes	Yes	Yes	Exhaust missing grate-blocked by cart, art project drying on univent, cleaning product on counter, window open, open access panel
Room 211	631	73	42	17	Yes	Yes	Yes	Window open

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Hosmer Elementary School, Watertown, MA – September 14, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 212	570	68	49	20	Yes	Yes	Yes	Window and door open, cleaning product on counter
Room 214	447	70	49	11	Yes	Yes	Yes	Window open, plywood over windows-spaces
Room 213	507	71	46	17	Yes	Yes	Yes	Exhaust blocked by boxes, window open
Main Office	484	70	52	1	Yes	No	No	Window open, vehicles outside
Room 9	735	73	52	1	Yes	Yes	Yes	Univent off-blocked with materials-shrubs outside air intake, exhaust off-blocked by cart, spray cleaner on desk
Room 13	575	70	47	18	Yes	Yes	Yes	Univent off-books on top, exhaust off, window open
Room 11	1244	74	55	18	Yes	Yes	Yes	Univent & exhaust off-electrical problem, windows closed
Restroom					No	Yes	Yes	Passive supply
Room 7	1020	76	49	19	Yes	Yes	Yes	Univent off, exhaust on, hole in wall, cleaning product on desk, construction vehicles on street

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Comfort Guidelines

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Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results – Hosmer Elementary School, Watertown, MA – September 14, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Gym	387	74	45	0	Yes	Yes	Yes	4 univents
Room 3	575	75	49	0	Yes	Yes	Yes	Cleaning product on desk
Room 1	586	75	46	1	Yes	Yes	Yes	Univent return blocked by various items, spray cleaning product on countertop-unlabeled
Room 103	548	77	45	1	Yes	Yes	Yes	Spaces around countertop, cleaning product under sink, accumulated dust on windowsill
Room 106	399	73	42	1	Yes	Yes	Yes	Items on univent –univent off due to noise, window and door open, construction vehicle outside, plant
Room 108	700	72	50	18	Yes	Yes	Yes	Fiberglass in univent, construction vehicle outside, cleaning product under sink, exhaust partially blocked
Guidance Office Suite	412	73	46	5	Yes	No	Yes	Window open, fresh air source-window-passive vents to offices
Room 112	411	71	47	5	Yes	Yes	Yes	Window open, exhaust vent blocked, dumpster outside

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Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – Hosmer Elementary School, Watertown, MA – September 14, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
								classroom, mislabeled cleaning product on counter: labeled "water"-citrus odor/color
Room 109	738	71	49	20	Yes	Yes	Yes	Window open
Room 107	882	73	49	15	Yes	Yes	Yes	Exhaust vent partially blocked
Room 105	825	75	49	0	Yes	Yes	Yes	
Room 205	526	75	45	0	Yes	Yes	Yes	Window open
Library (across from 205)	473	76	44	1	Yes	No	No	Sign-"keep out", sanding/drywall prep, books uncovered, window open

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